THE ACCURACY OF FORECASTS.[1]

By Jean Mascart.

There are two distinct tendencies in forecasting, one toward general, long-range forecasts, and the other toward very specific, short-period forecasts.[2] The use for which the forecast is made largely determines this tendency. The verification of the forecast is always a troublesome feature, for weather which may be favorable to one interest may be disagreeable to another. To be verifiable, the forecast should be precisely worded, for in a general forecast some part of it is almost certain to be verified.

Robert H. Scott, former head of the English Meteorological Office, stated that a verification of 70 per cent of the forecasts should be considered creditable. Sir Napier Shaw gives a figure of 56 per cent for forecasts 36 hours in advance. This leads the author to conclude that if claims of accuracy as high as 80 to 95 per cent are made they must be either utterly fantastic or based upon very general forecasts.

Rouch found upon testing Köppen's assertion made a long time ago that the weather tends to preserve its character, and hence that the weather of to-morrow will resemble the weather of to-day, that of 100 forecasts, 40 were good, 40 were fair, and 20 were bad. This is somewhat lower than was claimed by Köppen for certain forecasting rules which were not made public. One is left in doubt, therefore, as to what constitutes a satisfactory accuracy of verification.

It has often been loosely stated that on the basis of chance one should be able to forecast with 50 per cent accuracy. The author has tried this out in three experiments, using very precise forecasts, as follows:

(1) A person names a certain date at random, and a second person writes a forecast. This was done for a period covering more than six years. The accuracy was found to vary with the season, but in the mean the verification gave an accuracy of 52.2 per cent.

(2) Given a list of all the days in the year, a forecast is written for each. The accuracy varied from 50 per cent in December to 68.8 per cent in June.

(3) Based upon the statistics of 70 years, a forecast of rain positively worded—rain or no rain—gave a verification of 45.6 per cent in December to 66.7 per cent in June, a mean for the year of 54.4 per cent.

In the above experiments (1) and (2) the forecaster was familiar with the locality and its climate.

It seems from these considerations that 60 per cent is a reasonable lower limit for the satisfactory verification of forecasts upon the condition that the forecasts are very precise.

The author concludes upon the basis of his experience that an accuracy of 80 per cent in regional forecasts for 36 hours in advance is entirely to be hoped for.—*C. L. M.*

[1] La proportion des réussites dans la prévision du temps.
[2] The author implies that the tendency toward long-range forecasting is characteristic of work in the United States, owing to the agricultural and economic demands, and he cites the weekly forecast issued each Saturday. While it is true that this forecast has important bearing upon activities in the fields mentioned, it must not be forgotton that the short-time forecast for the use of aviation and other interests is given even greater attention by forecasters and students in the United States.

ON A WIDE-ANGLE LENS FOR CLOUD RECORDING.[1]

By W. N. Bond.

The special feature of this lens is that its field of view embraces a complete hemisphere, so that if the lens is arranged to face vertically upward all clouds visible may be recorded photographically on a single flat plate or film. The resultant photograph is circular, the clouds at the zenith being reproduced at the center of the circle and those near the horizon appearing near the edge of the circle. The resultant image differs from the true image by a very small amount.—*A. J. H.*

CONCERNING A METHOD FOR THE DETERMINATION OF PERIODS.

By E. Rubenstein.

In 1911 and 1913, W. Schmidt published papers relating to the determination of long periods in meteorological data[2] to which the present author takes exception.

[For the reader's information, the following brief abstract from the second paper mentioned above, gives the nature of Schmidt's method:

Given a series of values $a_1, a_2, a_3, \ldots$ we may write the differences of the individual values from the mean of the series, a, as

$$a_1 - a = a'_1$$
$$a_2 - a = a'_2$$
$$\cdot \quad \cdot \quad \cdot$$

Adding these values, step by step, we obtain,

$$b_1 = a'_1$$
$$b_2 = b_1 + a'_2$$
$$\cdot \quad \cdot \quad \cdot$$

Carrying the process further, we may take the difference between individual values $b_1, b_2, b_3, \ldots$ and their mean b, thus obtaining the values $b'_1, b'_2, b'_3, \ldots$ just as $a'_1, a'_2, a'_3 \ldots$ were obtained above. Similarly, this will lead to the values

$$c_1 = b'_1$$
$$c_2 = c_1 + b'_2$$
$$\cdot \quad \cdot \quad \cdot$$

Thus the various series b and c are closely related to the original data, and constitute, respectively, first and second integrations of the original function.

The original amplitude A when the integration embraces n intervals becomes $nA/2\pi$, and thus n is related to the amplitude of the curve representing the integral. If the operation is repeated, i. e., if the second integration is performed, the amplitude becomes $n^2 A/4\pi^2$. Thus the amplitude varies directly as the square of the

[1] Cf. Fassig, O. L., Mo. Weather Rev., 43:274.
[2] Nachweis von Perioden langer Dauer. *Met. Zeit.*, 1911, pp. 401–407; *ibid.*, 1913, pp. 392–394.

number of intervals embraced. In the integration described above the curve of the second integration is displaced above the original curve so that a maximum in a implies a minimum in c.]

The present author states this as follows:

Given the so-called quasi-periodic function

$$y = A_0 + \sum_{k=1}^{k=n} A_k \sin\left(\frac{2\pi}{T_k} t + \varphi_k\right)$$

which will be periodic if T_1, T_2, $\cdots$ T_k are commensurable; upon twice integrating this function the equation

$$Y = \sum_{k=1}^{k=n} -\left(\frac{T_k}{2\pi}\right)^2 A_k \sin\left(\frac{2\pi}{T_k} t + \varphi_k\right) + \frac{1}{2} A_0 t^2 + C_1 t + C_2$$

is obtained, in which C_1 and C_2 are constants of integration.

It appears that Schmidt did not take into sufficient account the significance of these constants of integration and introduced a fallacy in taking departures from the mean value of the function.

If

$$y = f(t),$$

the mean value of which is M, then

$$y_1 = f(t) - M.$$

Integrating once, we obtain,

$$\int_{t_0}^{t} y_1 dt = F(t) - Mt + C_1.$$

Instead of again integrating this function, we take the departures from the new mean M_2, the new function to be integrated becomes

$$F(t) - Mt + C_1 - M_2 = F(t) - Mt - M_1.$$

Upon integrating, we obtain

$$Y = \int_{t_0}^{t} F(t) dt - [M(t - t_0)^2/2] - M_1(t - t_0) = \phi(t) [Mt^2/2] - M_1 t + C.$$

Because of the repeated taking of departures from the mean, the quantity C_1 is not effective in the second integration, while the mean M appears in a parabolic term. Thus, a function which is really not periodic may be made to yield a second integral of parabolic form; this might be mistaken for a sine curve, and thus a period be found, which would have no reality.

Several examples of the inefficacy of this form of investigation are given. First, given a certain function,

$$y = \sin 10°t + \sin 30°t,$$

the second integral shows a period which is entirely different from that shown by the second integral of the expression

$$y = \sin 10°t + \sin 30°t - 0.28,$$

which is the function when subtracted from its mean.

Again, taking the departures from the hundred-year mean of temperature at Petersburg and constructing a second integral curve by Schmidt's method, a very long period is demonstrated, which obviously has no existence in the data themselves.

The author concludes that only if it is known a priori that superimposed trigonometrical functions are involved is this method applicable.—*C. L. M.*

BIBLIOGRAPHY.

RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. FITZHUGH TALMAN, Meteorologist in Charge of Library.

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

American institute of mining and metallurgical engineers.
Pyrometry. The papers and discussion of a symposium on pyrometry . . . at its Chicago meeting, Sept., 1919, in coöperation with the National research council and the National bureau of standards. New York. 1920. vi, 701 p. illus. 23½ cm.

Diaz, Severo.
El primer año de previsión del tiempo en Guadalajara. Resolución para esta ciudad del problema del pronóstico semanario. Guadalajara. 1922. 7 p. 28 cm.

Drosne, P.
Le beau, le mauvais temps et la relativité. Paris. 1922. 68 p. illus. 18½ cm.

France. Ministère des travaux publics. Aéronautique & transports aériens.
Radiogrammes météorologiques émis par les postes T. S. F. régionaux français. (En vigueur à dater du 1er novembre 1922.) [Paris.] 1922. 26 p. 31 cm. [Manifolded.]

Garnett, William.
Little book on water supply. Cambridge. 1922. xv, 144 p. illus. 22½ cm.

Giacomelli, R.
Alcune questioni di nomenclatura meteorologica (gelicidio, gragnola, nevischio, vetrone). Roma. 1922. 7 p. 24 cm. (Extr.: Atti dell'associazione italiana di aerotecnica. v. 1. 1920-21.)
L'opera della R. stazione aerologica principale di Vigna di Valle durante la guerra. Roma. 1922. 8 p. 24½ cm. (Extr.: Atti dell'associazione italiana di aerotecnica. v. 1. 1920-21.)

McKay, Robert James.
Recent progress in smoke abatement and fuel technology in England. Pittsburgh. 1922. v, 62 p. illus. 23 cm. (Mellon institute of industrial research of the University of Pittsburgh. Smoke investigation. Bulletin no. 10.)

Michigan. Bureau of agricultural development.
Michigan agriculture. 3. Climate. By Dewey A. Seeley. Lansing. 1922. 46 p. illus. 23 cm. (Michigan agric. series no. 3.)

Mossman, Roberto C.
Las condiciones físicas del Atlántico sur entre el Río de la Plata y las Islas Orcadas del Sur durante el verano. Buenos Aires. 1922. 26 p. illus. 31½ cm. [cf. p. 590, this REVIEW.]

Norway. Norske meteorologiske institut.
Nedbøriagttagelser i Norge . . . Middelværdier maksima og minima. Kristiania. [1920.] v. p. illus. plates. maps. 35½ cm. (Tillægshefte til aargang 24, 1918.)

Okada, T.
On the possibility of forecasting the summer temperature and the approximate yield of rice crop for northern Japan. 9 p. illus. plate. 26½ cm. (Second paper.) (Repr.: Memoirs imperial marine observatory. v. 1, no. 1.) [Cf. pp. 582-583, this REVIEW.]

Peppler, Albert.
Die Badische Landeswetterwarte Karlsruhe. Ihre Einrichtungen und Arbeiten. Karlsruhe i. B. 1922. v, 70 p. illus. plate. 25½ cm.

Rouch, J.
Manuel d'océanographie physique. Paris. 1922. 229 p. illus. 22 cm.

Störmer, Carl.
Les phénomènes d'aurore boréale et les problèmes qui s'y rattachent. [Helsinki. 1922.] p. 57-76. illus. plates. 25 cm. (Extr.: Congrès des mathématiques à Helsingfors. 1922.) (5e Congrès des mathématiciens Scandinaves.)

Weston, J. W., & others.
Agriculture of the upper peninsula. East Lansing. 1922. 82 p. illus. 23 cm. [Climate, p. 13 ffg.] (Michigan agric. college. Agric. exper. sta. Special bulletin, no. 116.)